PUBLIC HEALTH REPORTS

VOL. 37 AUGUST 18, 1922 No. 33

THE USE OF SEMI-LOGARITHMIC PAPER IN PLOTTING DEATH RATES.

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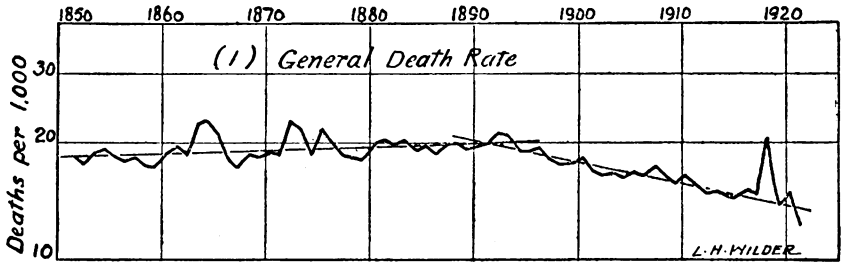
The use of semi-logarithmic paper for plotting death rates is not new, but its advantages have never been forcibly brought to the attention of health officers. It may be worth while, therefore, to give a few examples of its use.

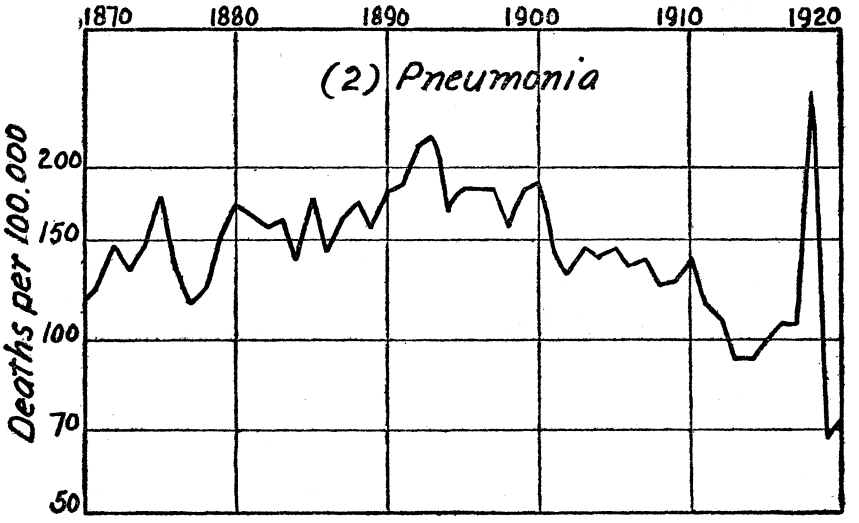
Semi-log paper has a vertical scale based on the logarithms of the numbers from 1 to 10, with subdivisions, and these repeat themselves, the distances between 1 and 10, 10 and 100, 100 and 1,000 being equal. The horizontal scale is arithmetical, i. e., uniform. The



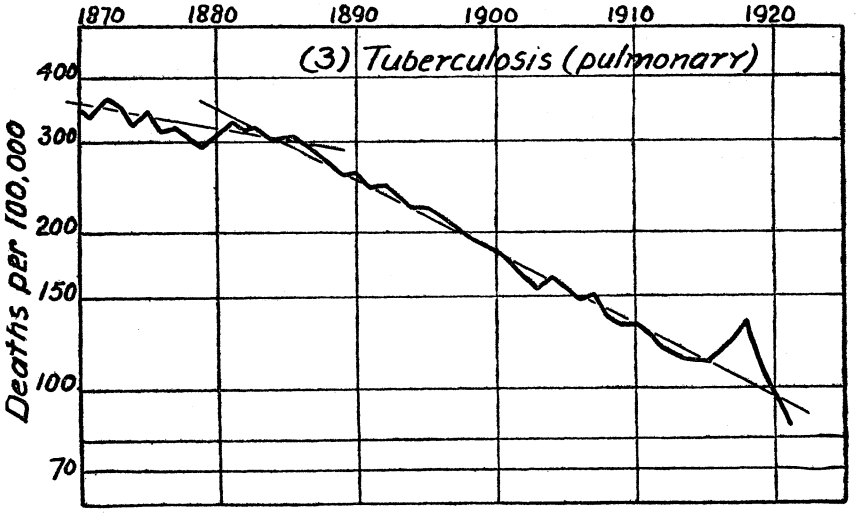
peculiarity of this combination of scales is that plotted data which have a constant rate of change produce a straight line. Money growing at compound interest, population growing at a geometrical rate, produce straight lines; and if plotted death rates yield a straight line sloping downward, it indicates that the rate of decrease is constant. It is especially useful for long-time records. When falling death rates produce a curve, as they often do on ordinary cross-section paper, it is difficult for the eye to detect differences in curvature; but when the plotted points fall upon a straight line for a time and the line changes abruptly in direction, one may more easily detect the time when the change began. A change in the direction of the line means that the rate of change has altered.

Referring to the graphs, (1) shows the general, or crude, death rates for Massachusetts during the last 70 years. From 1851 to

about 1890 the death rate rose very slowly from 18 to nearly 20 per 1,000. Then it began to go down and continued this decline, with some ups and downs, until 1921, when it reached 12 per 1,000. The rise during 1918, the influenza year, was conspicuous. What caused



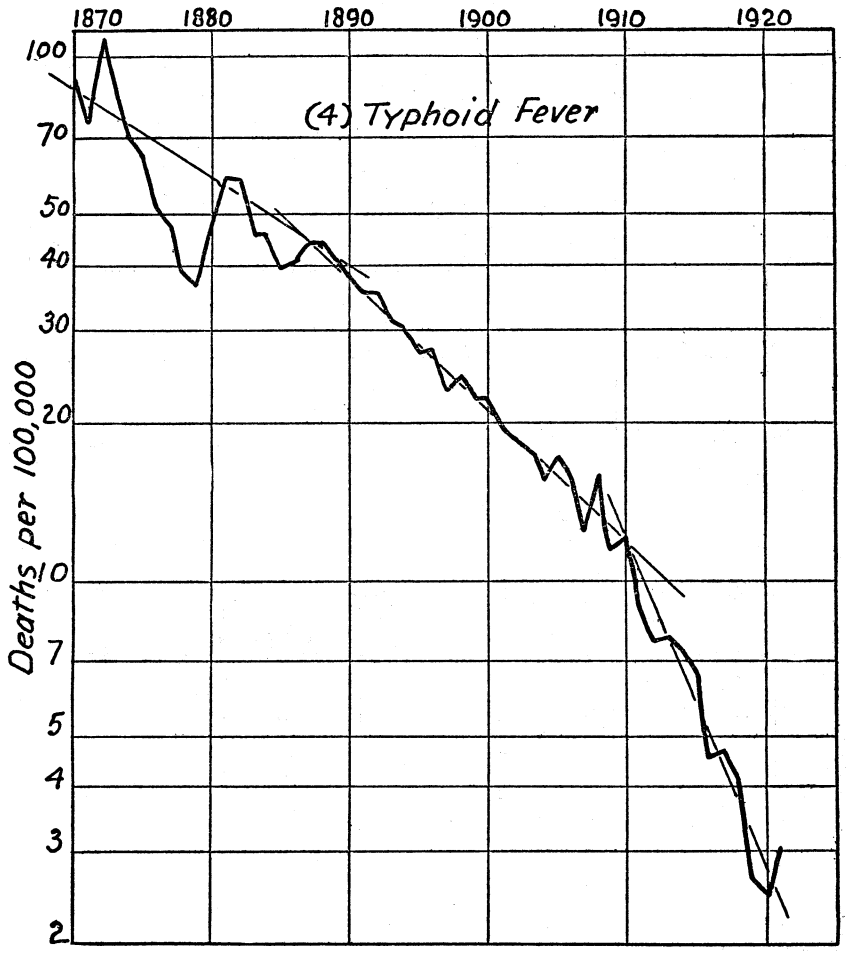
the change in 1890? It can be answered in a word—bacteriology. It was in the late eighties that active health-protective measures growing out of the earlier studies of Pasteur and his successors



began to be put actively into execution. It was at that time that the water-purification and sewage-disposal studies were made at Lawrence, while soon afterwards came the free distribution of diphtheria antitoxin by the State and the establishment of tuberculosis dispen-

saries and sanatoria. Later came other health measures, the pasteurization of milk (about 1910) being of especial importance.

An inspection of the plottings of various diseases is interesting. Graph 2 shows an increase in pneumonia between 1870 and 1893, then a steady decrease except for the influenza year. A few more years may show that the apparent break about 1912 was a real one.

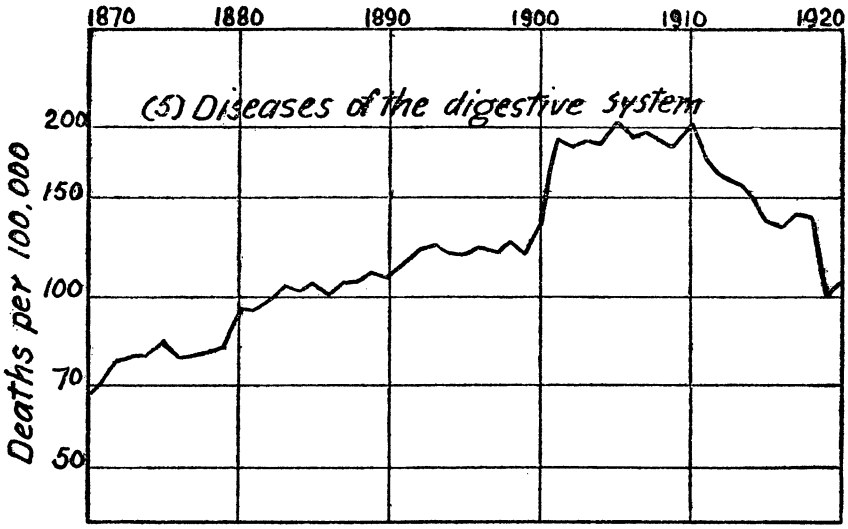


The high rate in 1893 and the drop after that year evidently had a marked influence on the general death rate.

Tuberculosis (3) has been steadily falling. A change in rate occurred about 1885; but since then it has had a steady decline, except for the influenza years. In the case of this disease, one may almost venture to predict its future death rate by extending the curve as a straight line. If the present decline continues, the death rate will be 38 in 1950, whereas now it is 82 per 100,000. This is a

much more conservative estimate than several estimates which have recently been made. Semi-log paper is better than ordinary cross-section paper for this purpose, because straight lines can be extended forward more accurately than curves.

Typhoid fever (4) has shown two breaks—one about 1888–1890, when the activities of the State board of health in the study of purification and sewage treatment were at their height, and another about 1910, when the pasteurization of milk was adopted extensively. There have been no sudden changes in the quality of the water supplies of the State, but a steady improvement due more to protective measures than to water purification or chlorination. Diseases of the digestive system (5) show a similar break about 1910. The increase about 1900 was due to changes in classification.

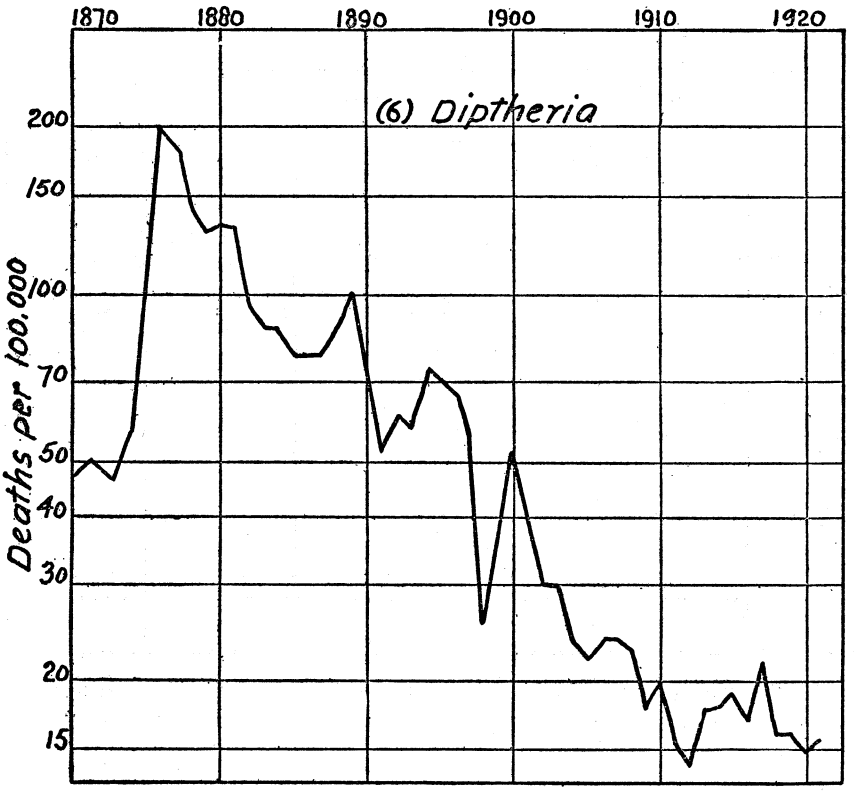


Diphtheria (6) shows a decline since 1876, when the rate stood at the very high figure of 200 per 100,000. The characteristic recurrences of this disease are evident, but their magnitude has lessened as time has gone on. For a long time the general downward trend was that of a straight line, but about 1910 the decrease began to slacken. Renewed efforts to control this disease will have to be taken or the death rate will decrease but little further. It is already quite low. This is likely to be the history of many of the communicable diseases—a decrease to some very low level, but no complete eradications; in other words, our public health efforts will result in effective control but not in extermination. When these low levels have been reached, efforts should be made, if possible, to reduce the cost of public health activities in so far as they relate to the disease in question, spending only enough money to keep them at a minimum. The law of diminishing returns here comes into play.

Scarlet fever (7) has decreased even more steadily than diphtheria in spite of the fact that the bacteriology of this disease is not well understood. The line differs from the diphtheria line in showing no reduction in the regular recurrences.

Graphs 8 and 9 show that measles and whooping cough have not yet been successfully controlled.

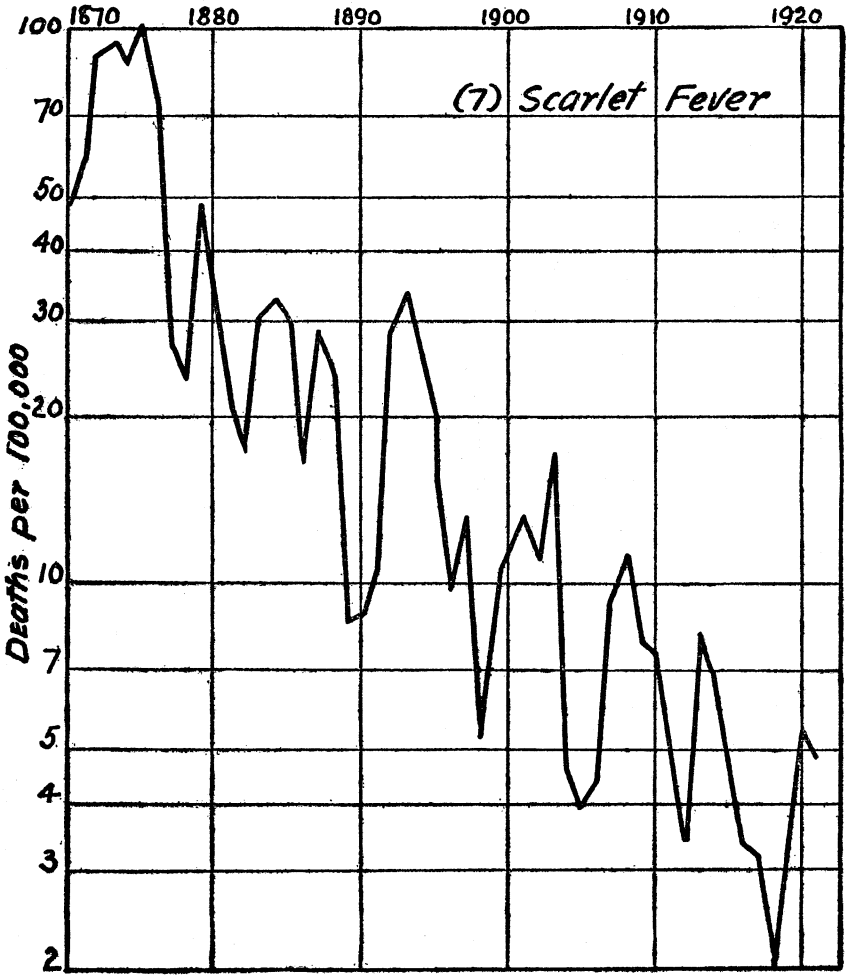
Infant mortality (10) maintained a level rate from 1870 to about 1890, save for a brief increase about 1872. Since 1890 infant mortality has fallen at a constantly increasing rate, the points falling on



a slight curve rather than a straight line. There appears to be a slight break in 1910, as well as in 1890, these two changes in rate reflecting improvements in the quality of water and milk supplies, respectively. General efforts in the direction of infant welfare have doubtless had their effect in causing the downward rate to accelerate, but sanitation seems to have been more effective than hygiene.

In contrast with these hopeful statistics we find that Bright's disease (11), cancer (12), and organic diseases of the heart (13) have been steadily increasing their death rates.

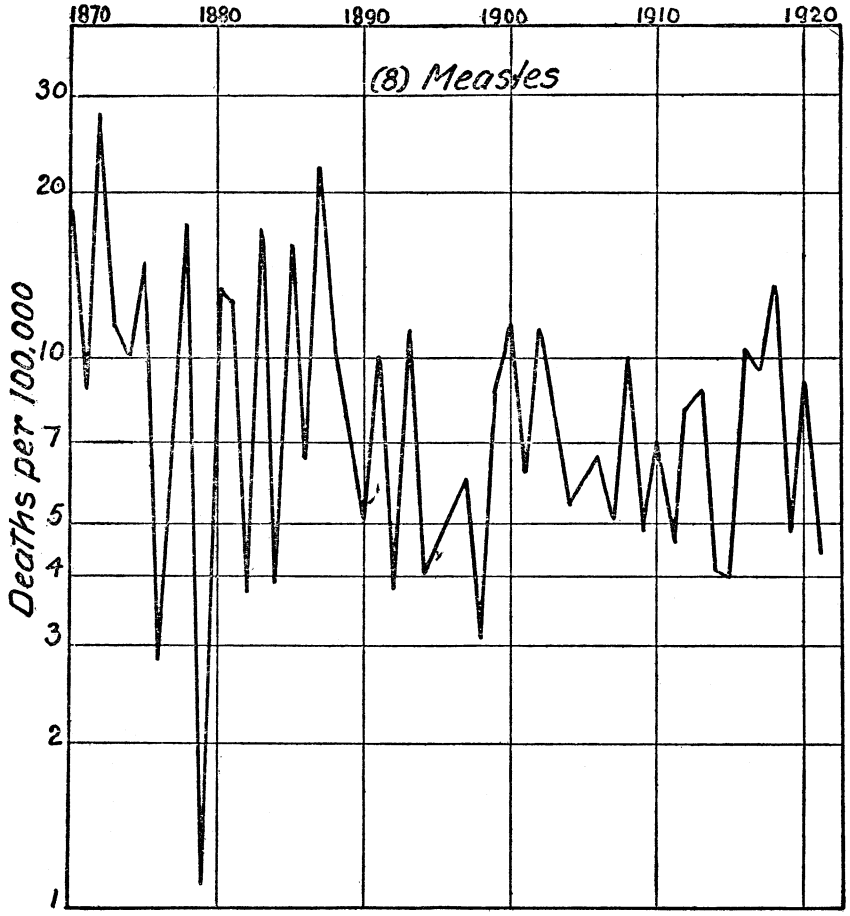
Suicide (14) also has steadily increased, with waves which are coincident with the years of financial panic. In spite of the increase in automobile accidents, the deaths from violent causes other than suicide (15) have not increased, but have kept a steady rate, with numerous fluctuations.



Deaths from alcoholism (16) are interesting in view of the recent prohibition amendment. There has been a marked decline since 1917. There was also a sharp decline after the Civil War and again in 1877. Even eliminating these low records, the death rates from this cause may be seen to have fallen gradually from 1880 to 1917.

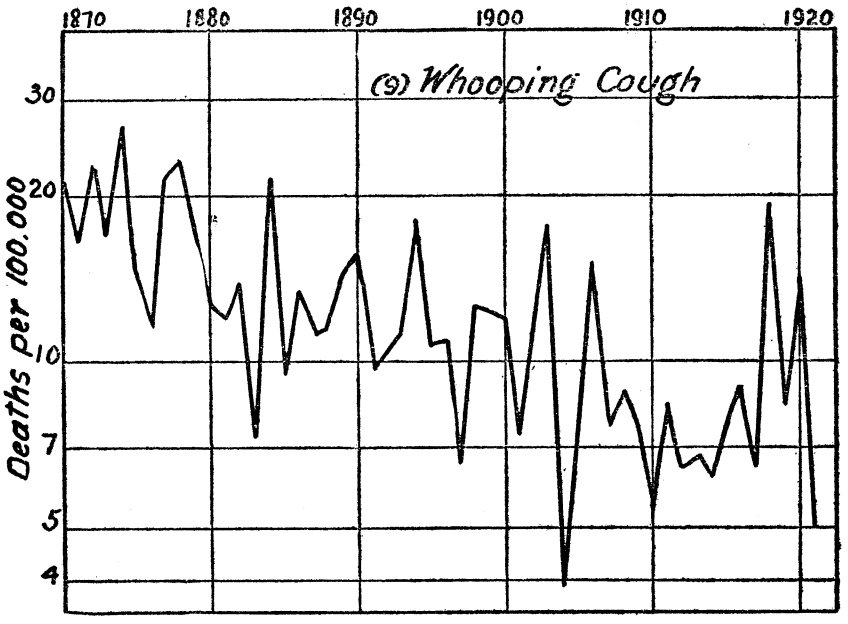
Graph 17 represents the specific death rates by age groups, plotted on semi-log paper. The noticeable observations are the accelerating downward rate of the "under 5" group; the rapid decline in groups

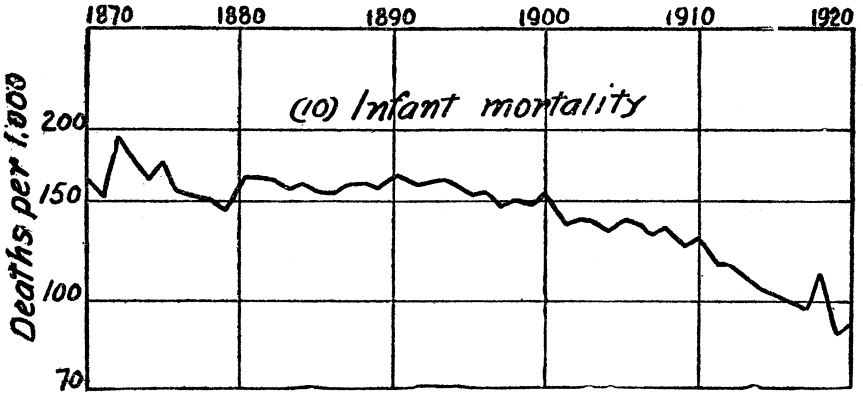
5–9, 10–14, and 15–19; the less rapid decline in groups 20–29, 30–39, 40–49; the almost steady rate for group 50–59; and the slightly increasing rates for the higher age groups. These observations are not new, but are well displayed by this method of plotting.

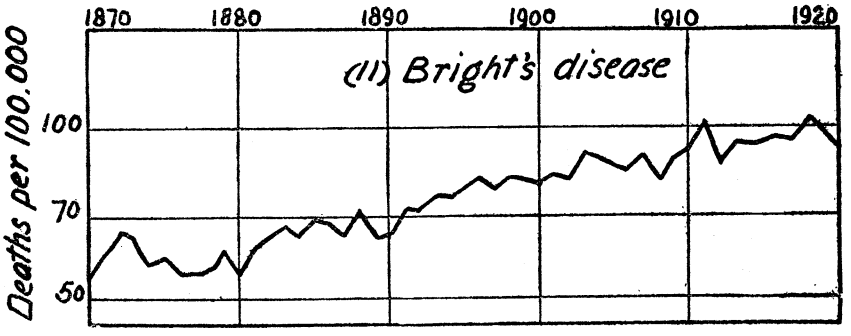


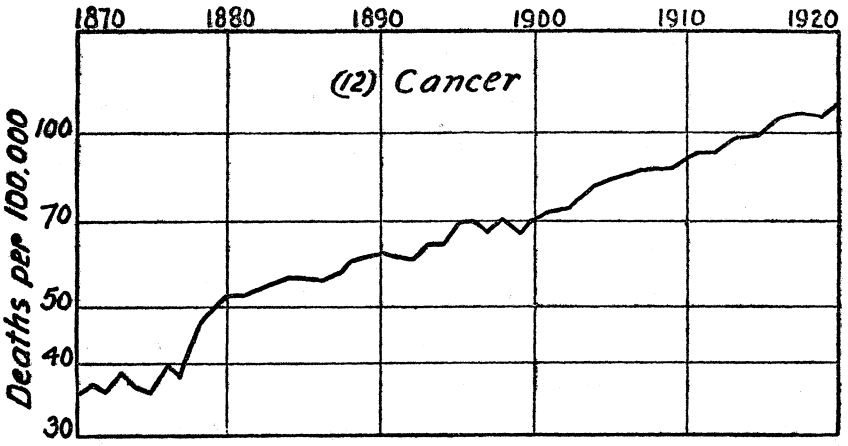
While semi-log paper is valuable for making comparisons of long-time records for purposes of study, health officers should not use it too freely in popular health instruction, because most people do not understand the logarithmic scale, with its irregular divisions, and do not appreciate the significance of the rate of change. It is not well adapted to plotting monthly changes in death rates, because in that case it is the actual seasonal change rather than the rate of change which is the important factor.

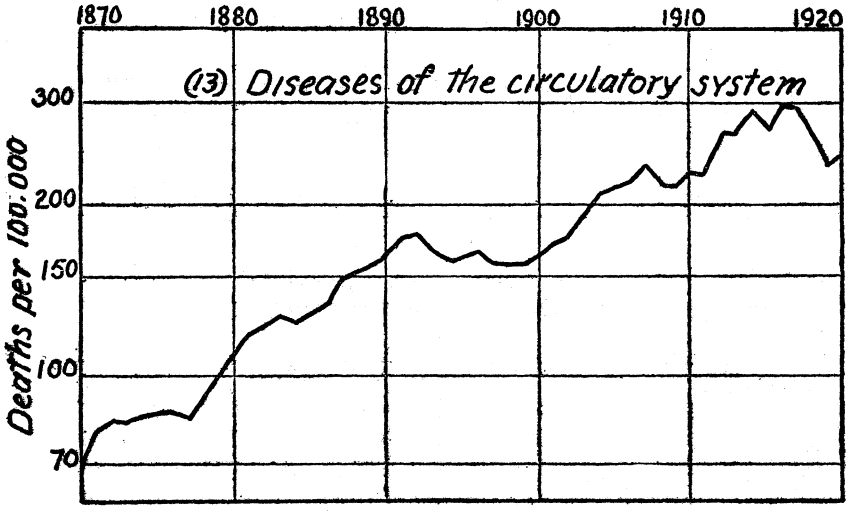
Semi-log paper, log-log paper, probability paper, and other kinds of plotting paper are of great assistance to epidemiologists in the

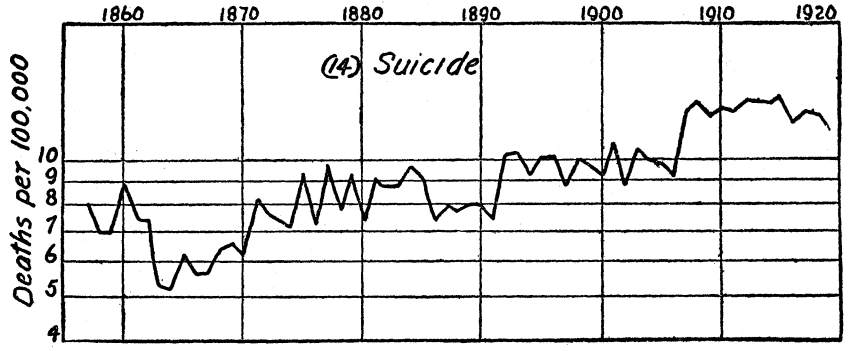

1870
1880
1890
1900
1910
1920
(9) Whooping Cough
Deaths per 100.000
30
20
10
7
5
4

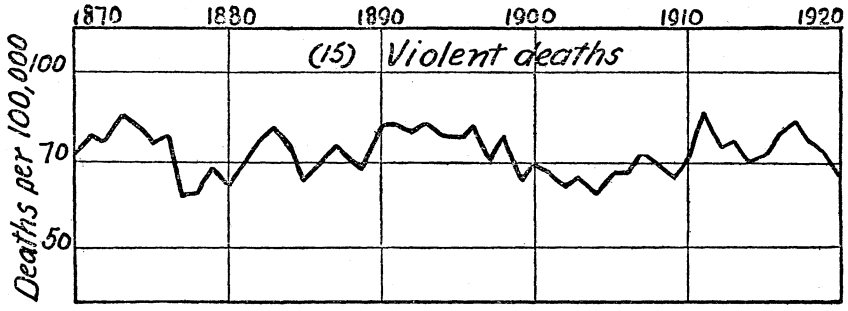

1870
1880
1890
1900
1910
1920
(10) Infant mortality
Deaths per 1.000
200
150
100
70

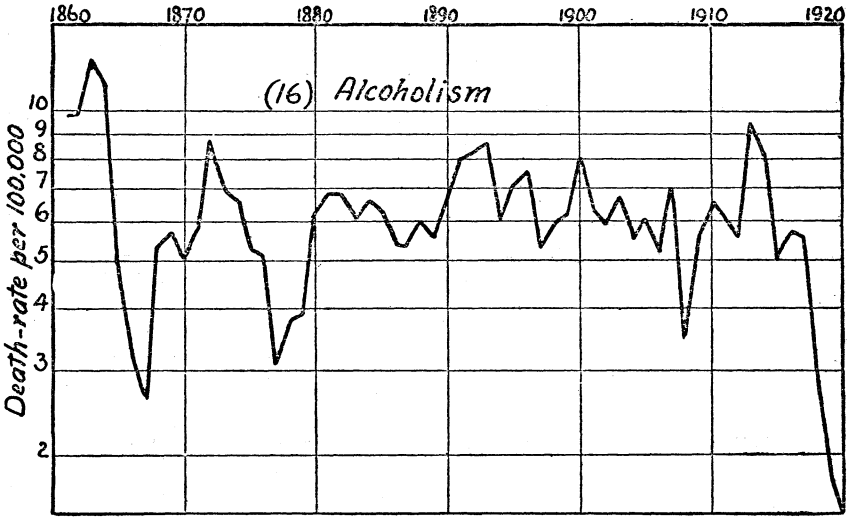

1870
1880
1890
1900
1910
1920
(11) Bright's disease
Deaths per 100.000
100
70
50


1870
1880
1890
1900
1910
1920
(12) Cancer
Deaths per 100,000
100
70
50
40
30

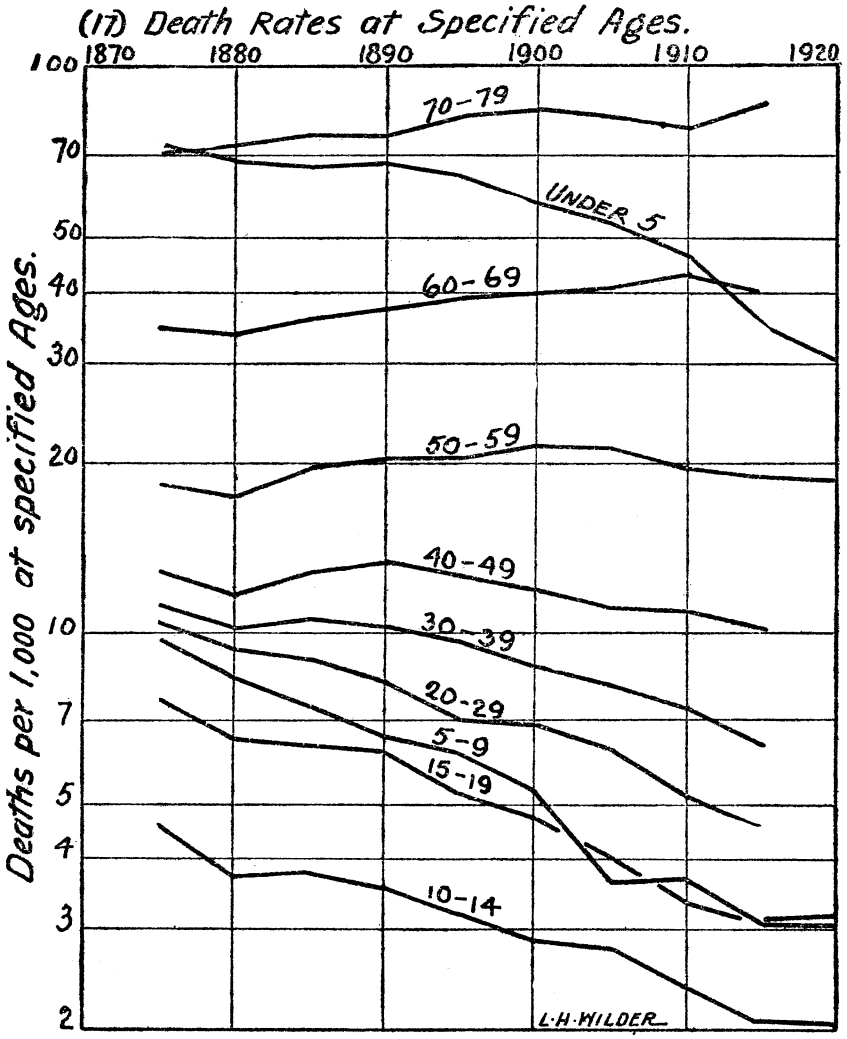

1870
1880
1890
1900
1910
1920
(13) Diseases of the circulatory system
Deaths per 100,000
300
200
150
100
70


1860
1870
1880
1890
1900
1910
1920
(14) Suicide
Deaths per 100,000
10
9
8
7
6
5
4





study of population and vital records, as well as in all sorts of biological and engineering studies. Vital statistics will soon pass out of its present elementary stage, and demography will come forth as a well-developed science—the science of the human generation, growth, decay, and death.



LIFE TABLES FOR STATES AND CITIES, 1920.

The Department of Commerce announces that abridged life tables based upon the 1920 United States Census will soon be issued showing conditions in 24 States and 14 large cities, also in the Territory of Hawaii.

Altogether these tables cover 74 per cent of the total population of the United States. They show for these States and cities taken as an aggregate that the expectation of life at birth is 55.23 for white males and 57.41 for white females.

According to these tables Kansas ranks highest, the expectation of life at birth in Kansas being 59.73 for white males and 60.89 for white females. Wisconsin ranks next with 58.77 years for white